Centralized Terminal Operation Control (CTOC) Concept

Capacity Increasing Concept TIM #3

NASA Ames Research Center

January 14-15, 2003

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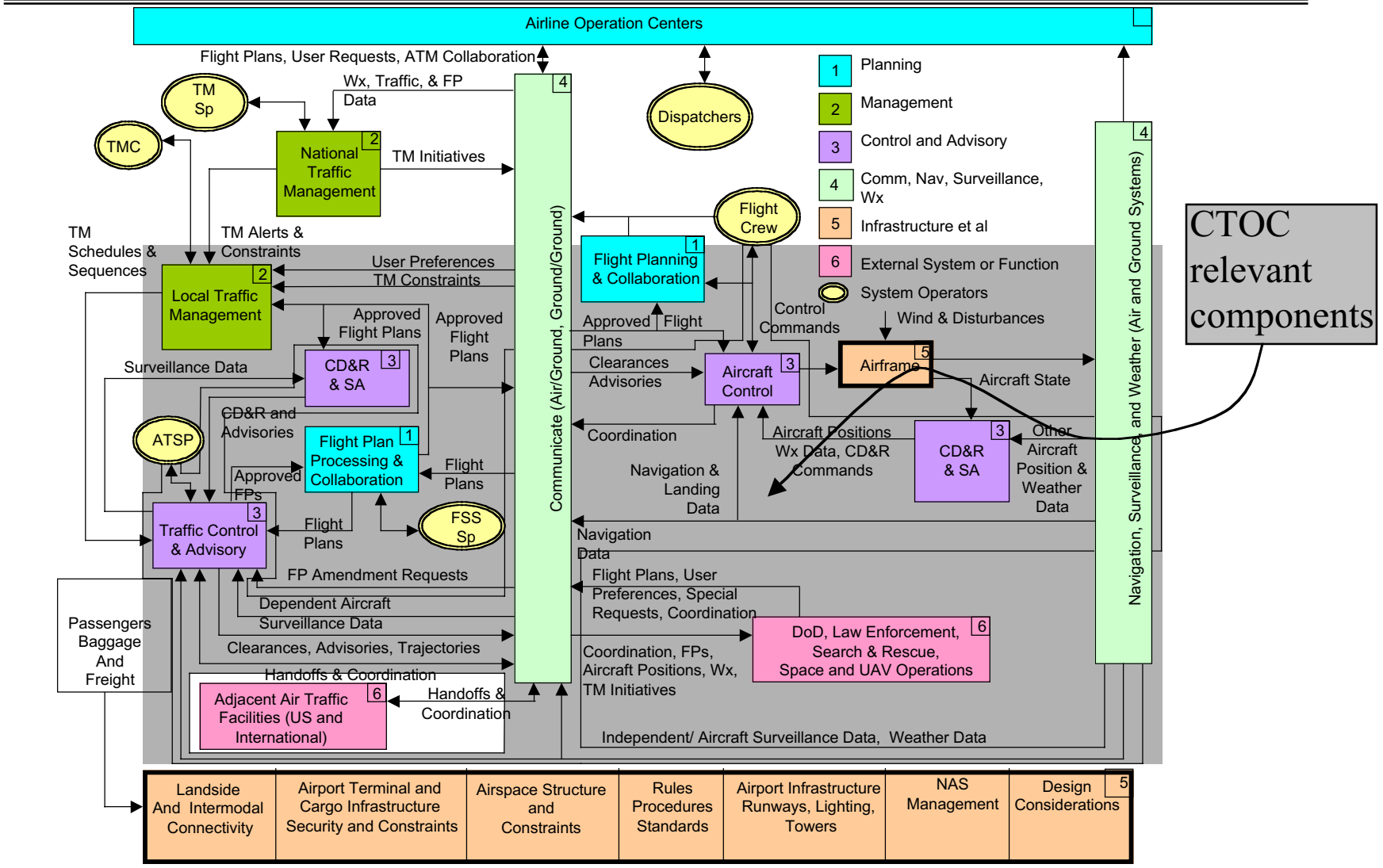
Overview

- CTOC Concept
- CTOC Core Ideas
- CTOC Objective
- CTOC Self-Assessment Plans

CTOC Concept

- The Centralized Terminal Operation Control (CTOC) provides remote control of aircraft in the Terminal domain
- CTOC merges the role of the controller and flight crews
- CTOC will interface to DSTs and/or enhanced ATM systems in the En Route, Terminal, and Surface environments to ensure predictable, consistent, conflict-free trajectories
- CTOC depends on aircraft technologies (i.e. data link and FMS) for response to Clearances/Advisories and Trajectory Commands from the Central Remote Controller

CTOC Concept



Modified VAMS Model of ATM Functions

CTOC Core Ideas

- Remote control of one or multiple aircraft from a single terminal specialist supported by a ground-based computer system
- Remote control will extend existing automation in the terminal domain and reduce variability in separation
- Trajectory commands based on deconflicted trajectories will be sent from CTOC to the aircraft FMS
- Remote control of terminal aircraft may be adjusted based on Air Traffic Management flow constraints
- Terminal specialists will have the capability to take control of aircraft to prevent unauthorized use
- Pilots will have the ability to override CTOC commands for safety reasons only

CTOC Objective

- Overall CTOC objectives are to demonstrate key ground-based and airborne technologies for the remote control of terminal area aircraft in all weather conditions to maximize terminal airspace capacity. The objectives are achieved through requirements definition and the development, integration and demonstration of enabling technologies, along with simulation-based demonstration and design verification. In demonstrating these objectives, the concept will show:
  - Greater terminal area throughput in all weather conditions
  - Reduced variability of separation for terminal area aircraft due to controller/pilot response
  - Increased terminal area safety due to control to predictable and consistent trajectories in the terminal area

CTOC Benefits/Metrics

Benefit	Mechanism	Candidate Metric(s)
Increased Capacity	Control to predictable and consistent trajectories in Terminal area	Throughput, Flow Rates, Arrival Delay, Departure Delay, Overall Delay, Time/Distance Flown
	Arrivals and departures make better use of Terminal airspace	Throughput, Flow Rates, Arrival Delay, Departure Delay, Overall Delay, Time/Distance Flown, Tracks
	Reduce variability in separation for aircraft-to-aircraft, aircraft-to-obstruction, and aircraft-to-airspace	Separation Distances, Conflicts
	Eliminate missed approaches due to verbal communication errors	Missed Approach Count
Increased Efficiency	Control to predictable and consistent trajectories in Terminal area	Tracks, Workload
	Improve situational awareness between Terminal ATC and airline users	Workload
	Eliminate missed approaches due to verbal communication errors	Missed Approach Count
	Collaborative arrival/departure management with airlines	Workload
	Reduce workload for Terminal area ATC and flight crews	Workload
	Provide communication between CTOC and FMS through data link	Comm Load, Workload
Increased Safety	Control to predictable and consistent trajectories in Terminal area	Separation Distances, Safety Incident Count, Conflicts, Workload
	Improve situational awareness between Terminal ATC and airline users	Safety Incident Count
	Provide communication between CTOC and FMS through data link	Comm Load
	Provide trajectory conformance monitoring	Separation Distances, Conflicts, Workload
	Provide flight deck override to CTOC	Safety Incident Count
	Provide ATC override for case of unauthorized use of Terminal airspace	Unauthorized Use of Airspace Count
Reduced Costs	Terminal area operating costs	Operating Costs, Staffing Levels

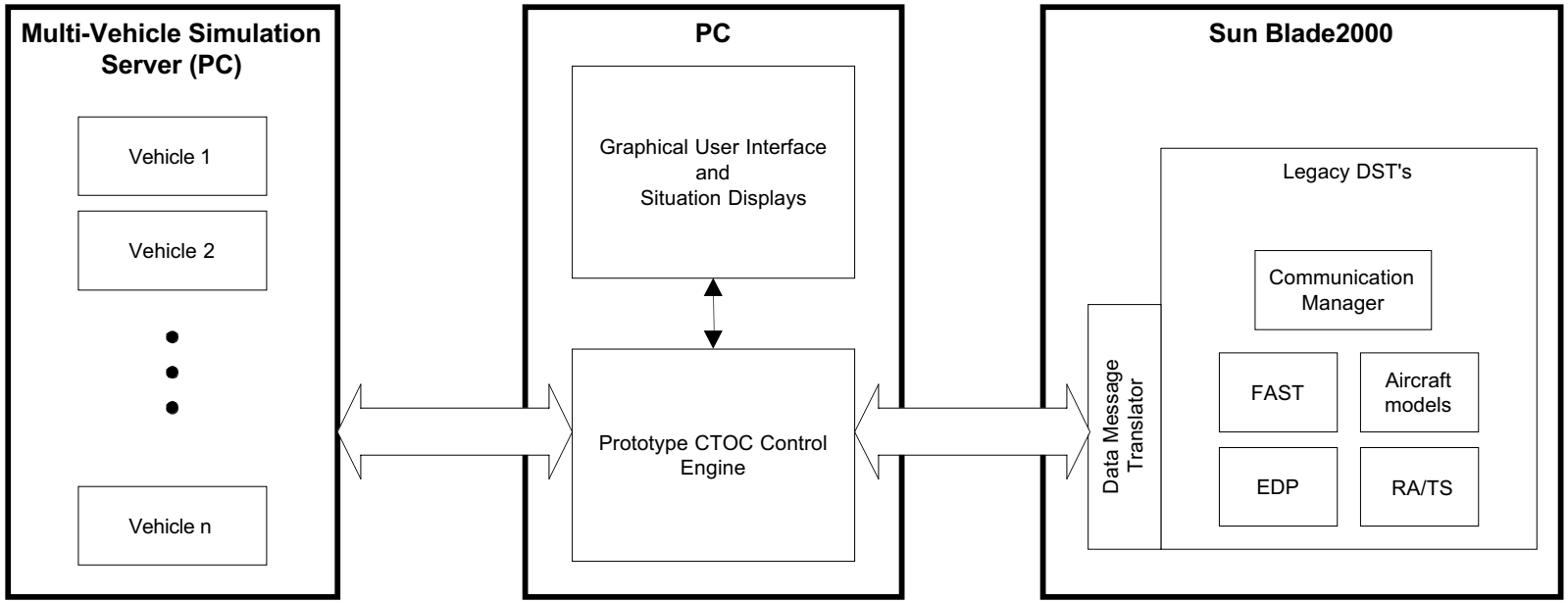
CTOC Self-Assessment

- Continue Terminal operations analysis started in Phase One
- Prototype Simulation Environment currently being integrated
- Will leverage CTAS toolset to establish de-conflicted trajectory data
- Preliminary active CTOC control laws synthesized
- Initial trials conducted on time delay separations
  - Demonstrates basic functionality
  - Provides domain for initial communication requirements studies
  - Currently simulating a generic GA airport to minimize complexity
- Next Steps
  - Integrate relevant airport
  - Validate extended CTAS functionality
  - Build multiple aircraft models
  - Ensure weather capabilities are addressed
  - Build multiple terminal area models

CTOC Prototype Simulation Test Environment

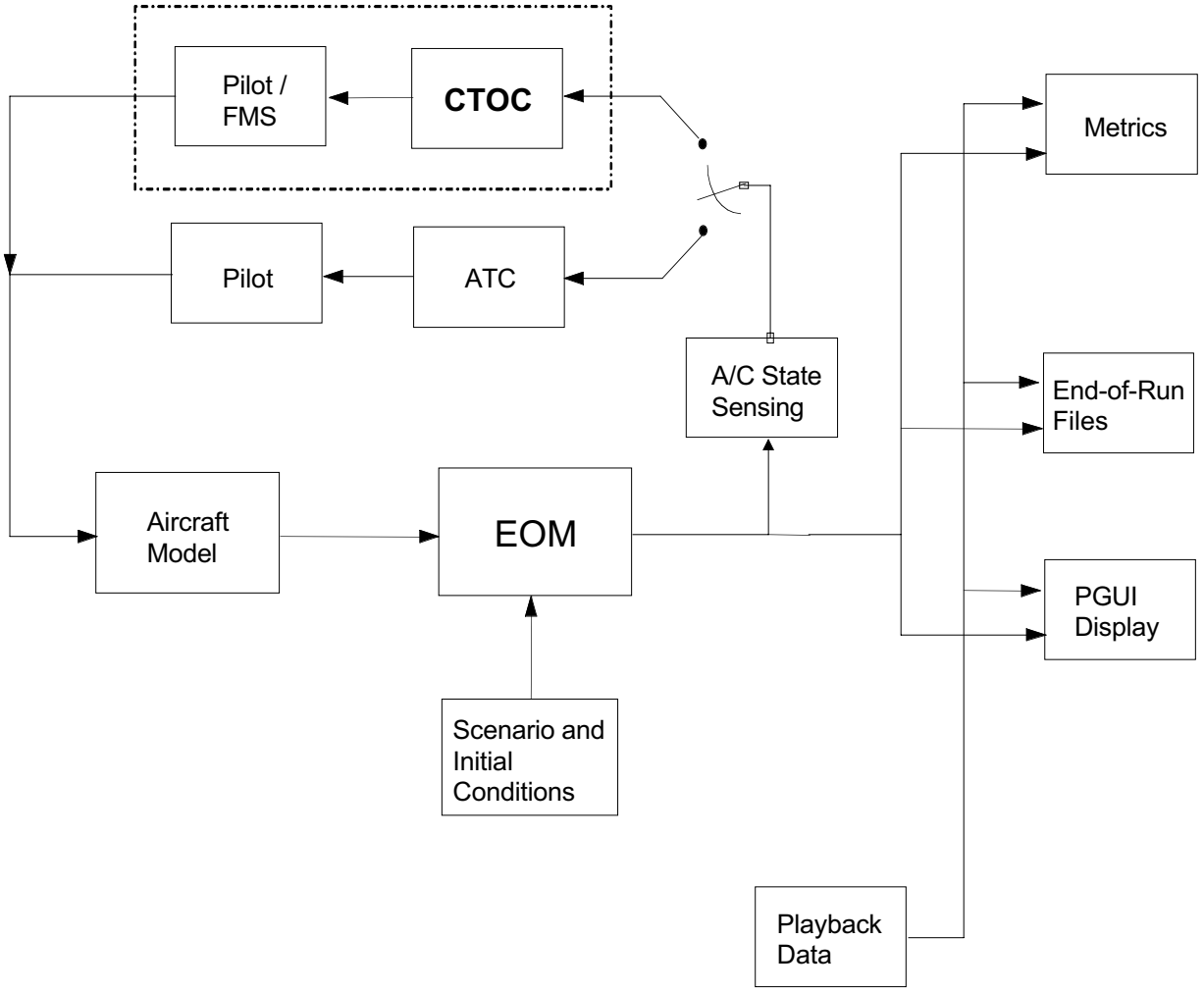
- Early-on progress will be established with a temporary simulation capability
  - Important for initial CTOC concept exploration and requirements definition
  - Will help to fine-tune CTOC-driven VAST requirements
  - Will provide valuable insight into merging and integration issues with other concepts
- Decision Support Tools will be an integral part of the CTOC success
- Closely-related NASA efforts have produced a toolset which provides an excellent starting point
  - FAST, EDP
  - CTAS-developed evaluation tools
- Geneva Aerospace's multiple vehicle dynamic simulation provides the real-time propagation of aircraft states

CTOC Prototype Simulation Test Environment



- Translator/extractor software being developed to interface existing situation display to FAST software
- Legacy DST's are hosted in existing environment to minimize development
- CTOC control engine will synthesize advisory commands by using CTAS-based DST's
- Will provide early-on insight into integration and merging issues, as well as providing an environment for initial CTOC requirements development

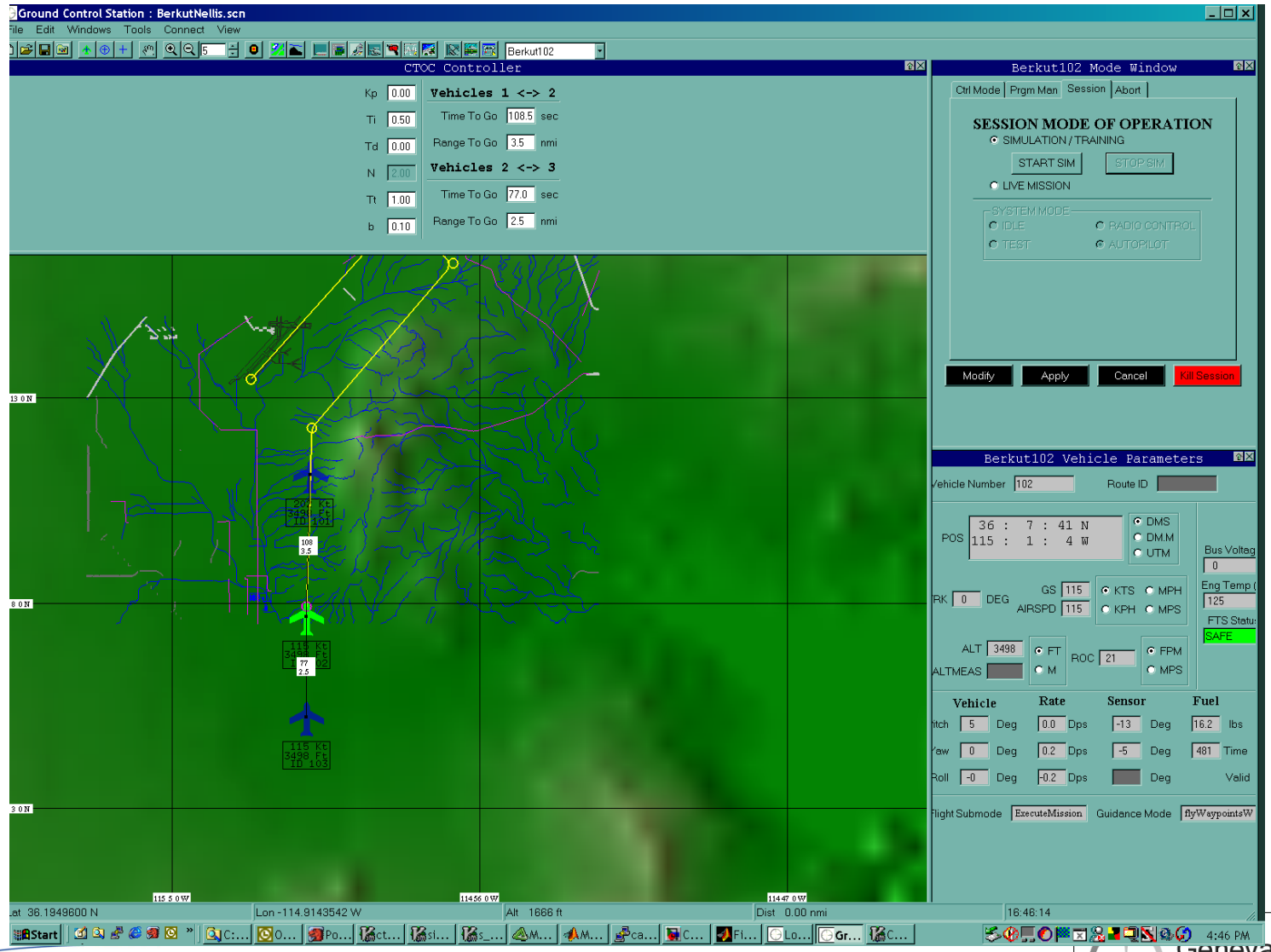
CTOC Prototype Simulation Functional Architecture



Summary

- Initial Phase of Concept Development Work Completed
- Top-level requirements have been identified, and flow-down structure has been established (TBD's/TBR's in place)
- Self-evaluation sim tool has been designed and integration is underway
- Will soon be prepared to enter the next phase of CTOC concept development
  - Requirements analysis and allocation
  - Detailed design and modeling of CTOC-specific elements
  - Detailed concept studies
  - VAST requirements definition

GUI for Prototyped Sim



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